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PROJECT REPORT

JANUARY 1982

DARCOM-LS-13-81

AD A126118

EVALUATION OF IN-PACKAGE PERFORMANCE OF ANTISTATIC MATERIALS, PHASE II

THE CONTENTS OF THIS REPORT HAVE BEEN REVIEWED AND APPROVED BY HQDARCOM

PREPARED BY:

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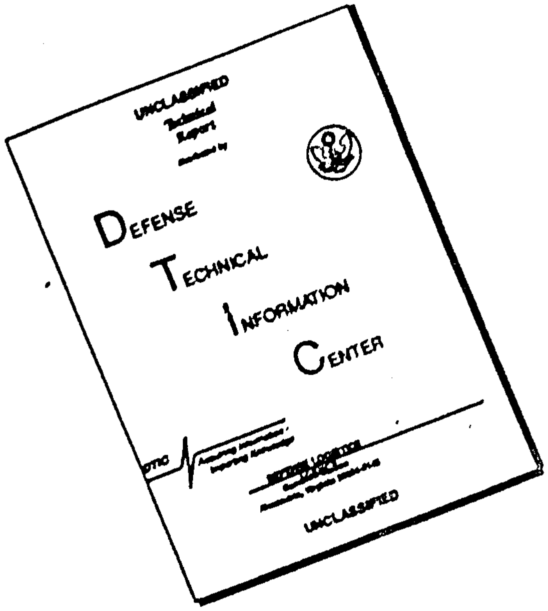

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ABSTRACT

This project is essentially a continuation of DARCOM Packaging, Storage, and Containerization Center (DARCOMPSCC) investigations into the establishment of a reliable "in-package performance" test procedure for evaluating the static charge propensity of packaging materials. Phase I, represented by Project Report DARCOM LS-8-80, dated November 1980, provides an important introduction and background into the inception of this procedure.

Refinements in the sensor assembly, attainment of higher voltage levels through variable frequency vibration inputs and pack resonances, and the development of a controlled humidity test container or fixture contributed toward the development of a reliable test method.

Additional static-free materials were tested to include conductive foam, pink polyethylene foam, pink transparent cellular bubble wrap, and pink cohesive polypropylene foam. The conductive foam exhibited excellent properties; the polyethylene foam was ranked very high; the latter two showed much lower ranking.

Efforts should now continue toward incorporating this test procedure into programs for further evaluations of static-free materials with emphasis on cooperation with other services in ongoing or planned projects.

US ARMY MATERIEL DEVELOPMENT AND READINESS COMMAND
PACKAGING, STORAGE, AND CONTAINERIZATION CENTER
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EVALUATION OF IN-PACKAGE PERFORMANCE OF ANTISTATIC MATERIALS - PHASE II

Project Report DARCOM LS-13-81

ROBERT McGILL
General Engineer

January 1982

CONTENTS

1. Introduction. a. Background established in the development of a reliable in-package test procedure was fully described in the Phase I project report. As a preliminary objective to the Phase II testing, however, DARCOMPSCC forwarded a letter to all Army commands; Air Force, Marine Corps and Navy activities; Defense Logistics Agency (DLA); and HQ, Defense Contract Administration Services (DCAS). The letter, included as appendix A, sought to acquire firsthand reports of static-damaged materiel. The Defense Electronics Supply Center responded:

> "We realize the seriousness of the ESD problem and the vulnerability of microcircuits and various electronic items to this source of damage. However, it is difficult for us to give you specific examples of items being destroyed or degraded because of the use of improper packaging materials. Items that fail prematurely or fail to function at all when put into use in the field are often just replaced and are not subjected to laboratory testing to determine what caused the failure. Even in such circumstances, it is difficult to know if the item was degraded before being packaged, while in the package, or if damage occurred due to improper handling after removal from the package."

Comments solicited from Air Force activities also indicated no direct traceability between component damage and packaging materials specified. However, Air Force Logistics Command (AFLC) indicated that "the consensus is that damage to electronic components does occur because of electric charge accumulation on packaging materials and that there is a need to identify suitable materials for protection against damage from electrostatic discharge." Their final comment relates to the fear of static damage resulting from the lack of a suitable packaging facility where electronic items are being repaired. DLA indicated that several of their contractors "are receiving material from subcontractors or vendors which are packed in what appears to be 'pink poly,' but which may not possess all of the necessary ESD-free characteristics." Further, "most contractors indicated that they rely heavily on in-house procedures such as grounded work stations, specialized material handling methods, etc. These respondents believe that much of the damage may occur during handling, prior to final packaging." In summary, there is an obvious lack of reportable data; but there are strong suspicions that damage may be currently occurring and may certainly occur in the future despite the ready availability of a number of static-free materials. Such damage may happen during any phase of the distribution cycle.

b. The basic objective of the Phase II effort was to continue investigations concerning the protection of static-charge-sensitive material through a further refinement of the in-package test procedure originated in Phase I. Particular emphasis was to be placed on testing at variable humidity levels and higher voltage levels expected to be produced through the achievement of test pack resonance. By attaining both of these conditioning environments, it was anticipated that greater reliability could be acquired in comparing static-free materials; the end result would be the ability to prescribe specific safe packaging methods. To accomplish the testing being planned, it was necessary to design a special test fixture for attachment to a variable frequency

vibration table, refine the sensor used in conjunction with the instrumentation, provide improved isolation of the testing area, and establish a method of humidity control within the test fixture. Details and discussion of the procedures used are provided in paragraph 2b.

c. During the concluding test phases of this report, a meeting was held at the Navy Air Development Center (NAVAIRDEVCEN), Warminster, PA. On 1 and 2 December 1981, the meeting was convened to evaluate the technical adequacy of the electrostatic properties testing as currently defined in the specification (MIL-B-81705). The minutes of this meeting comprise appendix B. The importance and significance of some of the final determinations of this meeting are provided in this report discussion following the test results.

2. Discussion. a. Preliminary. As with the Phase I report, it deserves mentioning that a static voltage buildup of 30-50 volts is sufficient to damage certain components. Increased voltage levels were anticipated from those observed in Phase I due to the greater mobility of test pouches resulting from established resonances of the tested packs. Such increases were expected to occur despite planned incremental increases in humidity conditions. Again, these voltage magnitudes are primarily useful in a comparative manner between packaging materials for determinations of static charge propensity.

b. Test preparation. As differentiated from the test preparation in Phase I, temperature control was sacrificed in order that simulated transportation conditions and vibration-induced test pack resonances could be obtained using a 500-pound capacity variable frequency (and amplitude) vibration table (ref 10, app C). However, during the course of the testing it was noted that temperature variations never deviated more than 4° F. from the average ambient temperature of 70° F. Appendix C identifies the total listing of instrumentation and associated materials with specific references to individual components.

(1) Static charge sensor (ref 12, app C). A major objective of the testing was to develop an improved sensor. After a number of trials using similarly sized printed circuit boards (PCB), it was determined that the most responsive configuration was one similar to that used in the Phase I testing, with some modification. A more secure means of cable attachment was achieved; a larger diameter shielded cable was used for lower-loss characteristics; and a conformal coating was applied over all exposed surfaces to provide uniformity for all tested materials. The output was connected through the shielded cable to the input of the electrometer (ref 2, app C) which in turn provided the output to the chart recorder (ref 1, app C). The modified PCB sensor is shown in figure 1.

(2) Tested materials. Due to the objective in achieving higher voltage levels, a single standard fast pack was used as the outer pack. This pack, identified as NSN 8115-00-787-2146, was chosen as an improved dimension for containing the PCB sensor within various pouch configurations. As in Phase I, the convoluted polyurethane (ref j, app D) offered opportunity for reduced effects which might be anticipated due to different test material thicknesses causing tightness of the total pack. The standard fiberboard used was W5c (ref i, app D). Packs were assembled with a small cutout in the corner of the fast pack container (for cable access); all tested materials were assembled as pouches; and packs were placed within a special test fixture (fig 2, 3, and 4).

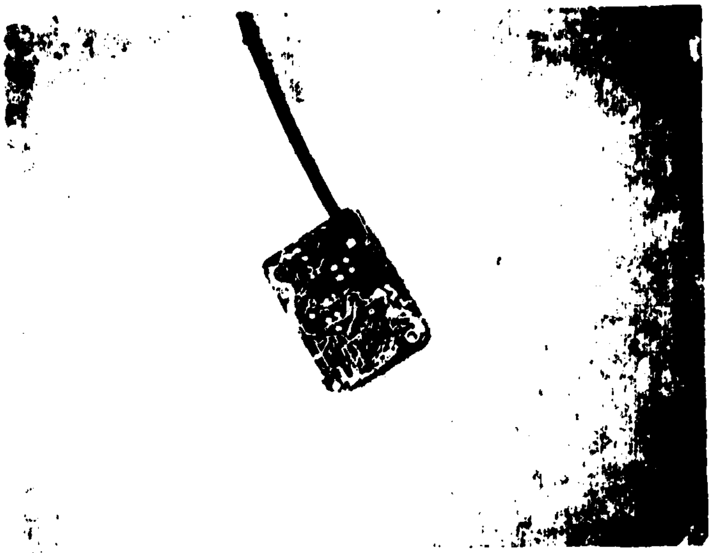

Figure 1. Modified sensor with improved low loss cable and conformal coating (Pace, Inc. 6999-0003).

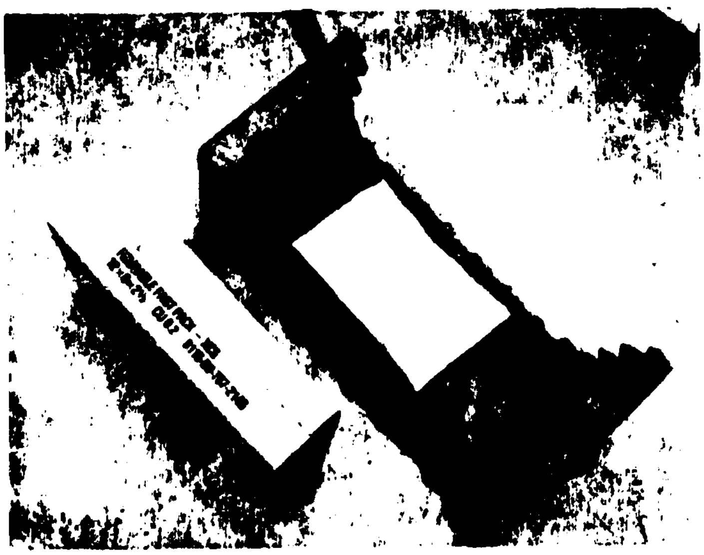

Figure 2. Sensor in typical pouch configuration; convoluted polyurethane fast pack container.

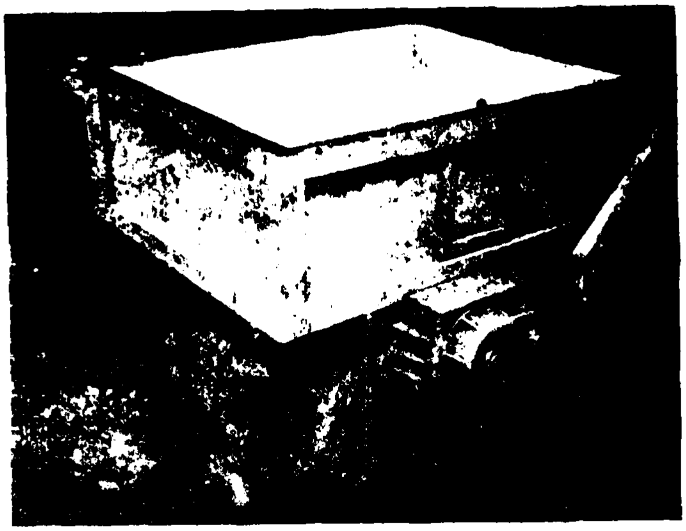

Figure 3. Test fixture and placement on vibration table.

Figure 4. Test pack secured within test fixture environment.

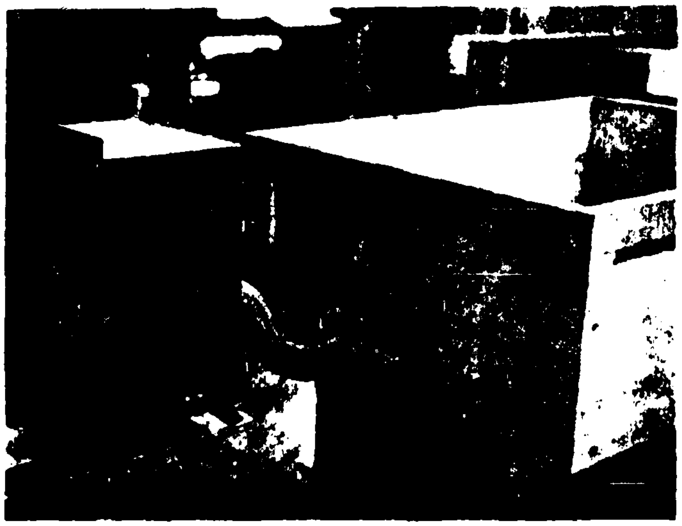

Figure 5. Dehumidification setup and assembly to test fixture.

For ease of materials referencing, appendix D provides complete descriptions of the tested materials. Where materials have exhibited prior compliance to specifications, this reference is further indicated. It is noted that, for consistency, materials tested in Phase I bear the same reference letter(s).

(3) Environmental controls. Humidity control was dependent upon the assembly of a special test fixture which could fit completely over the surface of the vibration table. The fixture was constructed of cleated plywood with a heavily braced cover designed to resist effects of constant vibration. Cross-members under the table secured the fixture. All fixture seams were caulked and a seal provided around the top edge to prevent excessive air leakage with the cover in place (fig 3 and 4). Dynamic dehumidification of the closed test fixture was gained through the use of a dehumidifier only (ref 6, app C, and fig 5). Humidity was monitored using a humidity transducer (ref 8, app C) attached to an 8-channel humidity recorder (ref 7, app C). Preliminary operation of the total assembly to include a vibration sweep to 30 Hz, was performed to determine structural adequacy and total effect on dehumidifier hoses and controls. Further modification or adjustment was found to be unnecessary. Following a long period of fixture conditioning, it was noted that a lower humidity level of 16 percent relative humidity (RH) was possible. Also, however, during this conditioning period, it was observed that ambient humidity conditions within the laboratory reached no higher than 28 percent RH. This was largely due to the heating requirements inherent in the laboratory during the early winter season. Since good humidity control was available between 16 percent and 24 percent RH, it was decided to perform all testing at these two parameters. The higher humidity level represented an approximate 40 percent increase in RH over the average range achieved during Phase I testing.

(4) Instrumentation area. During assembly of all of the material necessary for performing the tests to follow, it was noted that the static sensor, when in place, was highly sensitive to movement of individuals, packaging materials, etc. For this reason, a shroud comprised of conductive polyolefin was draped over the complete test fixture, and grounded. With this material in place, the sensor was unaffected even in the higher sensitivity ranges. Excellent selective grounding of the sensor was gained, further confirming the adequacy of the test setup in addition to the usefulness of the sensor itself. As a precaution, the complete test area was isolated within 10 feet of the sensor location. Figures 6 and 7 show the completed testing area.

c. Test method. The selected method for actual testing was changed from Phase I primarily due to the controllability of the vibration source. For this reason, testing times for each material test sequence was extended both from a conditioning and actual test standpoint. With this longer duration of time, it was anticipated that more significant observations could be made and voltage magnitudes averaged from vibration frequency sweeps. Although the static gun (ref 5, app C) was used through an entry point or hole in the test fixture for observing and recording shielding capabilities of various material pouch configurations, such data were not considered as having major influence in the acceptability of the in-package performance test procedure. Such information may be acquired in a distinctly separate test procedure, possibly as an adjunct to tests currently prescribed in MIL-B-81705. Phase I testing also indicated a lack of significance in the area of consideration. As with

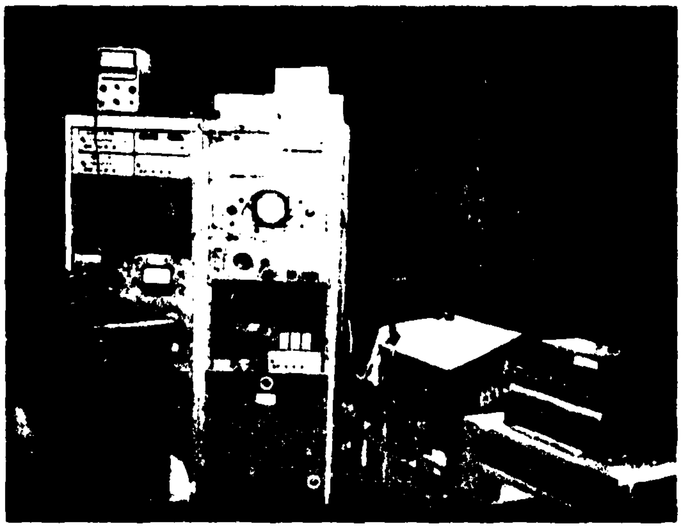

Figure 6. Final instrumentation and working area.

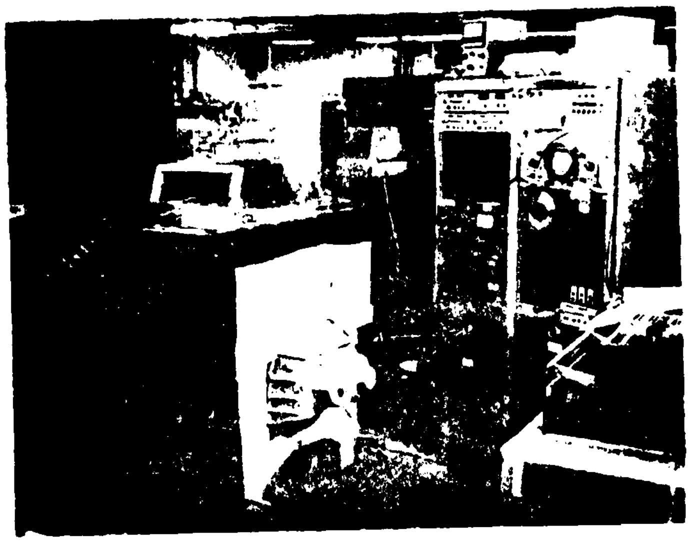

Figure 7. Testing area showing conductive shroud over test fixture.

Phase I, the established test method insured consistency through exact placement of the test pouches within the test fixture. Continual monitoring of humidity levels was performed, and a constant rate of vibration frequency sweep was maintained. The complete sequence of steps for environmental conditioning, pouch testing, and data recording are identified as follows:

(1) Assemble pack using selected materials for test made up in pouches (8 inches by 5½ inches).

(2) Place within test fixture (fig 8 and 9).

(3) Vibration condition the pack for one complete vibration frequency sweep at the selected RH within the fixture (3 to 25 Hz and return in 5 minutes). Sensor shall remain grounded during the complete cycle.

(4) Select electrometer scale for test sequence to follow.

(5) Using the same sweep rate as in (3) above, commence vibration, remove ground from sensor, and operate chart recorder (ref 1, app C) at 1 mm per second. Perform two complete sweeps while monitoring static charge buildup.

(6) Stop vibration. Monitor static charge bleedoff, if any, for a short period.

(7) Ground sensor; stop chart.

(8) Set vibration frequency at predetermined resonance point of pack.

(9) Start chart; unground sensor and initiate vibration.

(10) Monitor static charge buildup for a plot length of 240 mm.

(11) Stop vibration. Monitor static charge bleedoff, if any, for an approximate 100 mm.

(12) Ground sensor; stop chart.

In steps (5) and (10), record voltage magnitude. For step (11), record percent bleedoff after 25 mm of chart plot length. It is further noted that the referenced "resonance" in step (8) was to be obtained prior to the complete sequency of testing. Resonance, for purposes of this report refers to the point at which greatest sensor mobility occurs within a typical test pack as evidenced by a rapid increase in static charge buildup. In this case, a determination was made that a frequency of 20 Hz produced such an effect. As confirmation of this frequency standard, a strobotac (ref 11, app C) was used prior to and during steps (9) and (10). An electrometer scale of 30 was used as a constant throughout the testing. Full scale deflection of the chart, therefore, would approximate a buildup of 25 volts. As noted earlier, such a buildup is hazardous to certain electronic components. Therefore, recorded data in the tables may note "exceeds" where materials have exhibited serious static charge characteristics. To measure beyond this point would not be significant, except to differentiate between a general grouping of materials which exhibit poor static charge propensity characteristics.

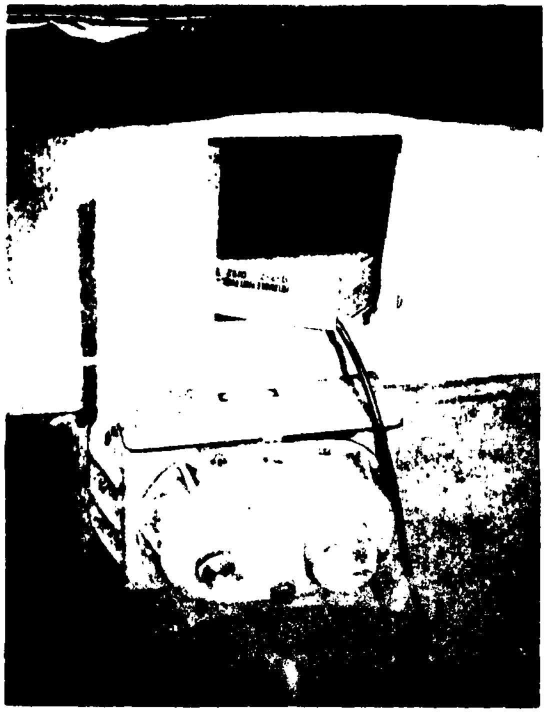

Figure 8. Insertion procedure of test packs within test fixture.

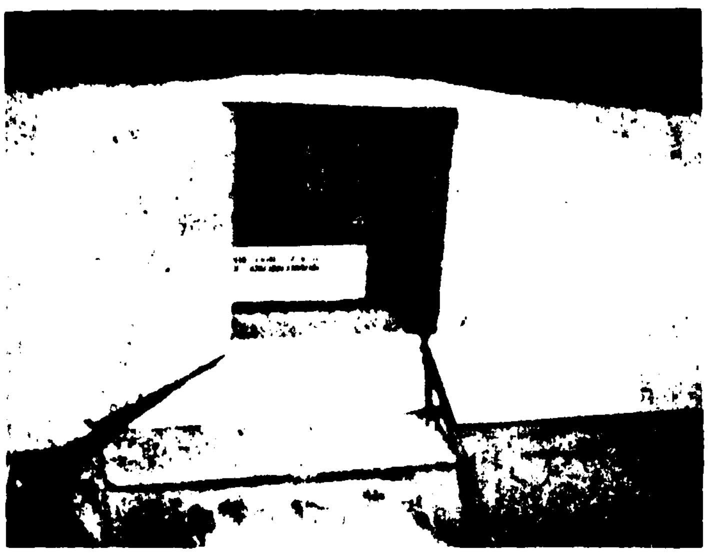

Figure 9. Test pack secured prior to conditioning and test.

d. <u>Test results</u>. Test data were gathered using the methods identified in c above. For purposes of refining the test procedure, material combinations were not tested. Similarly, standard packs were used throughout. Use of this procedure at a later time for determining specific packaging analyses and particular commodities would be appropriate. As stated earlier, the voltage magnitudes obtained are useful for comparison purposes between the various promising materials and further indicate obvious hazards which may exist with certain other of the tested packaging materials. Through the use of a modified sensor and a more closely monitored instrumentation area, improved isolation was achieved. A typical example of the completely charted test sequence is identified as figure 10. Note that the average voltage magnitude for the two sweeps would be about 24.5 volts at the 16 percent RH environmental condition. Test results from the entire sequence of packaging materials tests are presented in table 1. Results are in order of test performance. Table 2 is further provided as an indicator of relative desirability in using the tested materials for packaging of static-charge-sensitive components; the materials grouped where little differences exist.

Table 1

Material (app D)	16% RH			24% RH		
	Avg volts f sweep	Volts @20 Hz	Decay (%)	Avg volts f sweep	Volts @20 Hz	Decay (%)
DD	24.5	15	41	18	14.5	54
CC	17	14	45	12.5	10	48
BB	Exceeds	21.5	32	23.5	19	35
AA	Neg	Neg	NA	Neg	Neg	NA
D	Neg	Neg	NA	Neg	Neg	NA
A	15.5	18	40	15	17	46
B	17	19.5	52	17.5	18	47
C	21	13.5	35	22.5	12	33
E	Exceeds	Exceeds	NA	Exceeds	Exceeds	NA
F	Exceeds	Exceeds	NA	Exceeds	Exceeds	NA
G	Exceeds	Exceeds	NA	Exceeds	Exceeds	NA
m	Exceeds	Exceeds	NA	Exceeds	Exceeds	NA
n	14.5	20.5	25	15	18	32
o	18	19.5	28	16	15.5	28
s	Exceeds	23.5	15	Exceeds	21	17
u	Exceeds	Exceeds	NA	Exceeds	Exceeds	NA
v	No recorded data		-	No recorded data		-

Note: All voltages recorded to nearest 0.5 volts.

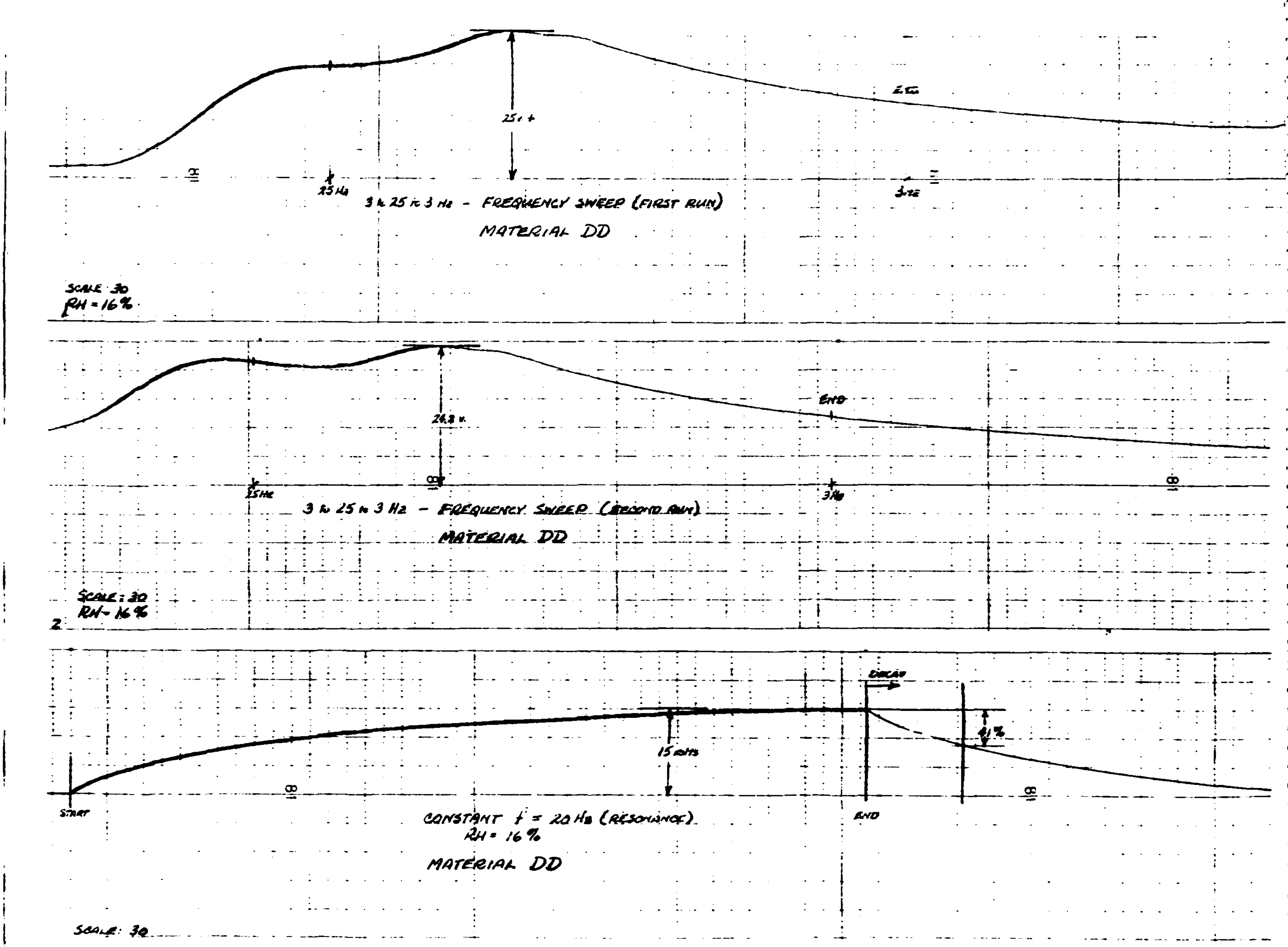

Figure 10. Typical test sequence and measurement.

Table 2

Ranking	Material	Description
Best	D	Conductive black polyolefin film
	AA	Conductive black urethane foam
Good	CC	Pink polyethylene foam
	A	Hexagonal pink polyethylene cushioning
	C	Transparent pink polyethylene film (nonspecification)
	B	Transparent pink polyethylene film (specification)
Moderate	n	MIL-B-121 barrier
	o	MIL-B-131 barrier
	DD	Pink transparent cellular bubble
	BB	Pink cohesive polypropylene foam
	S	Polyethylene foam
Poor	E	Opaque green coated barrier
	m	Transparent cellular bubble
	F	Transparent metallized laminate
	G	Opaque foil laminate
Worst	u	Polypropylene foam

(1) Performance of static-free materials. Of the claimed or proven static-free materials, six proved to have desirable antistatic properties. The materials were D, AA, CC, A, C, and B. The conductive nature of materials D and AA was evidenced by negligible charge buildup even at resonance conditions. Of the four materials remaining which looked particularly promising, material B showed the highest decay percentage on the average despite somewhat higher voltage buildups at resonance. Materials DD and BB were essentially similar in test results with a preference given to material DD based on a good average decay percentage and a somewhat lower voltage buildup. Materials E, F, and G showed poor characteristics, as they did in Phase I testing, with the exception of material E. Since this material is an experimental variety, this change cannot be explained except for a suspected relationship of vibration resonance and its effect on the film's structure.

(2) Performance of "common" materials. Materials n and o, both sealable barriers, showed surprisingly good characteristics. Their buildup was as good as some of the other better static-free materials, although their decay rates were somewhat less. This decay ability contrasts with that exhibited in the Phase I tests. However, improved isolation and controllable vibration are factors producing this result. Material s reacted as a borderline material,

close to material BB in voltage buildup, but sharply lower in decay ability. Materials m and u were poor in all areas with material u exhibiting severe static charge propensity.

(3) Effect of incremental changes in RH. It is noted that an increase in RH from 16 percent to 24 percent in general caused a lowered propensity for static charge buildup and a corresponding increase in decay rates. This would normally be the expectation, but there were some exceptions. Both materials B and C showed a lower decay rate upon increasing RH with very little change in voltage buildup. This apparently is related to their similar film structures; both are polyethylene films with antistatic additives.

(4) Stretch film trials (materials v). Some stretch films were investigated and formed into pouches to determine static charge propensity. These tests were run with the knowledge that increased utilization is anticipated. Complete data were not recorded but there should be cause for concern in such future applications. Polyvinylchloride (PVC) film particularly showed dangerous characteristics. Conversely, two with ethylene-vinyl acetate (EVA) additives performed as well as the two moderately antistatic materials, DD and BB.

e. Comment on appendix B. The minutes of the NAVAIRDEVCEN meeting exhibit a very promising approach to future testing in connection with the determination of antistatic properties of materials. It indicated that a modified decay rate test is being proposed "wherein the material being tested is in bag form and the clamping brackets are total insulators." Further development of such a technique is being planned. An additional plan is to "develop data on the performance of various materials as a package when exposed to the transportation environment." Further, it is intended to "determine the influence that a metal foil laminate has on the electro-static performance of various materials as packaging materials." From the DARCOMPSCC standpoint, it is now obvious that an opportunity for change exists both in specification reliability and the establishment of "real world" test methods. The test method described within this Phase II report has proven to be a reliable method of determining the "footprint" of various packaging materials either singularly or in combination.

3. Conclusions. a. The test procedure initially prepared in Phase I and refined within this Phase II report has shown excellent reliability in predicting the static charge propensity of packaging materials. Although the modified sensor used in Phase II testing was found to be suitable for this purpose, it is not intended that this sensor design be considered as a final configuration for incorporation into a future test procedure establishment.

b. The use of two RH levels showed some variation in static performance that can be expected in either desiccated sealed packs or dry environmental conditions where packs are not sealed.

c. The conclusions reached following the Phase I tests regarding the need for specification changes and newer test procedures have been amplified through the NAVAIRDEVCEN meeting. The use of this procedure and our involvement in their future efforts are extremely important.

d. Both tested conductive materials were shown to be excellent in resisting static buildup.

e. Common barrier materials, in both Phase I and II, showed similar or better performance than certain claimed static-free materials. Opportunities may exist to selectively use such materials without sacrificing static charge protection.

f. The best of the antistatic materials (other than the conductives) proved to be all polyethylene, either in film or foam form.

g. The most dangerous of all of the materials tested proved to be plain polypropylene foam; this material exhibited rapid static charge buildup with the associated hazards where sensitive components are exposed.

h. There appears to be substantial hazards connected with the application of stretch films. Preliminary tests indicate sharp differences between the variety of films currently being marketed, with those containing EVA additives and PVC types representing the apparent extremes in static charge propensity (low and high).

4. Recommendations. a. The "in-package performance" test procedure should be offered to the Navy for their future considerations. In this proven technique, performance can be predicted more closely than any current test or combination of tests. In this connection, DARCOMPSCC should remain cognizant of further proceedings of NAVAIRDEVCEN.

b. In the interim, and as part of future packaging analyses, this test procedure should be used to determine potential static discharge problems, and packaging material prescriptions should be changed where required.

c. As lead service activity, the procedure should be used for determining static charge propensity of singular new antistatic materials.

d. Based on the urgent requirements for stretch film implementation and the preliminary indication of a static charge problem, a project should be established to determine:

(1) Static charge propensity of each variety of stretch films.

(2) Static discharge hazards associated with the stretch wrap operation itself.

(3) Static discharge hazards in connection with wrapping, handling, and unwrapping of various sensitive commodities.

APPENDIX A

DEPARTMENT OF THE ARMY

HEADQUARTERS TOBYHANNA ARMY DEPOT

TOBYHANNA, PENNSYLVANIA 18466

REPLY TO ATTENTION OF

SDSTO-TE

13 AUG 1981

SUBJECT: Effects of Electrostatic Discharge (ESD) on Packaging Material

Commander
US Army Tank-Automotive
Command
ATTN: DRSTA-GSP
Warren, MI 48090

1. The DARCOM Packaging, Storage, and Containerization Center (DARCOMPSCC) is continuing its investigation into the potential hazards associated with the use of various common packaging materials which possess a propensity for static charge buildup. Preliminary tests have already been conducted on a number of these materials along with a group of commercially available "static-free" types.

2. This testing has shown that under low-humidity conditions and normal transportation cycles, static charge buildup may occur on both common and specially treated packaging materials. In storage, most of these same materials will not shield against a static discharge. The end result in both cases could be damage to items sensitive to even small ESD voltages. Unfortunately, many component failures, either immediate or at least premature to their known useful life, are not readily identifiable to ESD.

3. Thus far, laboratory testing has shown the feasibility in the establishment of an in-package performance test which, when refined, will provide a reliable method for determining electrostatic charge/discharge characteristics of the total package; i.e., item preserved, wrapped, blocked, braced, cushioned, cartonized, unitized, etc. Such an approach is necessitated since this testing has also shown that some materials, either complying with current specifications having ESD requirements or being claimed as "static-free" from commercial suppliers, have been shown to be deficient in this area when exposed to a simulated distribution environment.

4. Damage to selected items has already been reported to this Center from several activities despite their prescribing "static-free" specification materials. Further, we have observed that many more materials are becoming commercially available

SDSTO-TE
SUBJECT: Effects of Electrostatic Discharge (ESD) on Packaging Material

which essentially imitate (through color or other ways) such specification materials. ESD problems are actually being compounded by both the manufacture of more highly sensitive electronic items and the accelerated rush to market of many varieties of packaging materials, many of which do nothing other than introduce a false sense of security.

5. Based on this background, our Center solicits your comments regarding problems which have been brought to your attention--those packaging areas either directly identified to or suspected as being related to ESD. For further information, please contact Mr. Robert McGill, AUTOVON 795-7630.

FOR THE COMMANDER:

Anthony Alfano for

OSCAR C. HAERTSCH
Chief, Engineering and
Laboratory Division
DARCOM Packaging, Storage,
and Containerization Center

APPENDIX B

DEPARTMENT OF THE NAVY
NAVAL AIR ENGINEERING CENTER
LAKEHURST, N J 08733

IN REPLY REFER TO
9321/110:TRM:mp
10 December 1981

From: Commanding Officer, Naval Air Engineering Center
To: Distribution

Subj: Minutes of Meeting on MIL-B-81705, Barrier Materials, Flexible, Electro-Static Protective, Heat Sealable; forwarding of

Encl: (1) Minutes of Meeting

1. Minutes of the meeting on the subject specification, held at the Naval Air Development Center on 1 and 2 December 1981, are forwarded herewith.

2. The ESSD Project Engineer, Mr. T. Major, may be reached on (201) 323-2628 or AUTOVON 624-2628 for additional information.

T. W. COZINE
By direction

9321/110:TRM:mp

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Naval Sea Systems Command (Code 61Z41)
Washington, DC 20362

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Minutes of Meeting on MIL-B-81705
at NAVAIRDEVCEN, Warminster, PA on 1 and 2 December 1981

I. The meeting was convened to discuss the status of Amendment 2 to MIL-B-81705, Barrier Materials, Flexible, Electro-static-Protective, Heat Sealable and to develop a plan to evaluate the technical adequacy of the electro-static properties testing as currently defined in the specification.

II. A draft of Amendment 2 to MIL-B-81705 was presented by NAVAIRENGCEN. After considerable discussion, the following course of action was determined:

(a) NAVAIRENGCEN will incorporate several minor changes to the draft of Amendment 2 as suggested by attendees.

(b) A "permanence of marking" test must be developed and included in the amendment.

(c) ASO will investigate the impact of removal of the pink color restriction for Type II material on their supply operations.

(d) After implementation of (a) and (b), and with the assumed concurrence of ASO, NAVAIRENGCEN will send Amendment 2 to the printer.

III. The present test for electro-static properties (decay rate measurement) was demonstrated in the NAVAIRDEVCEN laboratory. NAVAIRDEVCEN also unveiled a modified version of this test wherein the material being tested is in bag form and the clamping brackets are total insulators.

After in-depth discussion, the following plan was developed with a goal toward the future improvement of the MIL-B-81705 specification:

(a) NAVAIRDEVCEN will:

1. Further develop the new electro-static test technique described above.

2. Investigate tests and procedures already developed for determining the propensity for triboelectric charge generation for various materials.

3. Develop data on surface resistivity for various materials.

4. Develop a matrix of the results of the above three approaches in an attempt to determine a relationship between the three techniques.

5. Develop data on the performance of various materials as a package when exposed to the transportation environment.

6. Determine the influence that a metal foil laminate has on the electro-static performance of various materials as packaging materials.

7. Develop a schedule and cost estimate for this planned effort.

(b) NAVAIR will provide authorization and funding to NAVAIRDEVCEN, if possible, for the above-outlined work.

(c) NAVAIRENGCEN will:

1. Request that bags fabricated from MIL-B-81705 material be appropriately marked in MIL-B-117.

2. Prepare a "Revision C" to MIL-B-81705 to incorporate any changes that evolve from NAVAIRDEVCEN's testing effort as described above.

3. Advise the preparing activities for specifications of other types of electro-static free materials of required changes, if necessary.

(d) NAVSEA will:

1. Provide technical support in the ESD area.

2. Act as liaison between the ESD community and the packaging community to assure open communication channels between the two disciplines.

IV. The meeting provided an opportunity for candid discussions within DoD activities that have an interest in electro-static device protection - either from a packaging or ESD viewpoint. It is intended that a similar meeting be convened in June 1982 to review the status of MIL-B-81705 and its revisions.

APPENDIX C

Equipment and Material Listing

Reference Number	
1	Brush Pen Type Chart Recorder, Model 440
2	Keithley Solid State Electrometer, Model 610C
3	Tektronix Storage Oscilloscope, Type R564B w/2A63 Differential Amplifier and 2B67 Time Base
4	3M Company Static Meter, Model 701 w/5, 10, 20KV ranges (+) or (-)
5	Zerostat Static Eliminator
6	Atlantic Research Corp. Desomatic, Model CB-8
7	Honeywell 8-Channel Humidity Recorder, Model No. Y15303836
8	Honeywell Humidity Transducer, Model Q457A
9	Vibration Meter, CEC, Model 1-110-B
10	L.A.B. Corp. Vibration Test Machine, RVH, Type 36-500, Serial No. 51802
11	General Radio Co. Strobotac, Type 1531-AB
12	Electrometer Sensor, Modified Printed Circuit Board

APPENDIX D

Tested Materials Listing

Reference Letter*	
A	Transparent, Open-Cell Cushioning Material, Hexagonal Shape, Pink Color, Electrostatic Free; IAW PPP-B-1842. Antistatic property added in the form of a conductive surface layer over an extruded polyethylene resin.
B	Transparent Polyethylene Film, Pink Color, Electrostatic Free; IAW MIL-B-81605. A nonlaminated plastic sheet formed from a homogeneous antistatic resin mix.
C	Transparent Polyethylene Film, Pink Color, Electrostatic Free. Antistatic property added in the form of a conductive surface layer over an extruded polyethylene resin.
D	Opaque Electrically Conductive Polyolefin, Black Color. Volume conductive achieved from carbon loading of the plastic resin.
E	Opaque Foil Laminate Barrier, Coated, Green Color, Electrostatic Free. Unknown antistatic property additive.
F	Transparent Laminated Film, Gray Color, Electrostatic Free. Laminate of polyethylene and polyester with the antistatic property achieved with an outer coating of conductive nickel.
G	Opaque Thin Film Laminate, Silver Color, Electrostatic Free. Laminate of polyethylene and polyester with the antistatic property achieved with a sandwiched layer of metal foil.
H	Not used in Phase II.
AA	Conductive Foam. Material appears to be a polyether type polyurethane; black color. Claimed to be noncorrosive.
BB	Polypropylene Foam, Pink Color, Cohesive Surfaces, Electrostatic Free.
CC	Polyethylene Foam, Pink Color, Electrostatic Free.
DD	Transparent Flexible Cellular Cushioning Material, Pink Color, Electrostatic Free.

*Capital letters indicate either claimed or previously proven antistatic properties inherent with the material. Double capital lettered materials are new to this testing phase.

Reference Number

i	Standard Corrugated Fiberboard. W5c fiberboard used in sleeve portion of reusable fast pack container, NSN 8115-00-787-2146, 12 x 8 x 2½ inches, fast pack type XC5.
j	Convoluted Polyurethane. Used as standard cushioning media for tested fast pack container.
k	Not used in Phase II.
l	Not used in Phase II.
m	Transparent Flexible Cellular Cushioning Material; IAW PPP-C-795.
n	Barrier Material, Greaseproofed; IAW MIL-B-121.
o	Barrier Material, Water-vaporproof; IAW MIL-B-131.
p	Not used in Phase II.
q	Not used in Phase II.
r	Not used in Phase II.
s	Unicellular Polyethylene Foam, 1/16-inch thick sheet for pouches; IAW PPP-C-1752.
t	Not used in Phase II.
u	Unicellular Polypropylene Foam, single thickness for pouches; IAW PPP-C-1797.
v	Assorted Stretch Films.